DOCUMENT RESUME

ED 322 007 SE 051 519

AUTHOR Corn, Juliana, Ed.; And Others
TITLE Teaching Remedial Mathematics to Students with Learning Disabilities.
INSTITUTION Queensborough Community Coll., Bayside, N.Y.
SPONS AGENCY Department of Education, Washington, DC.
PUB DATE 89
GRANT GOO8630155-88
NOTE 85p.
AVAILABLE FROM Professor Sandra Peskin, LD Math Project, Department of Mathematics, Room S-245, Queensborough Community College, Bayside, NY 11364 ($10.00).
PUB TYPE Guides - Non-Classroom Use (055) -- Guides - Classroom Use - Guides (For Teachers) (052)

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS Algebra; Arithmetic; Audiovisual Aids; *College Mathematics; *Community Colleges; Computer Assisted Instruction; Computer Uses in Education; Higher Education; *Learning Disabilities; Learning Strategies; Mathematics Education; Program Descriptions; *Remedial Mathematics; Teaching Guides; Teaching Methods; Tutorial Programs; Two Year Colleges

ABSTRACT

This handbook was developed as one of the objectives of a 3-year federally-funded model project to teach remedial mathematics to community college students with learning disabilities (LD). The underlying theme of this document is to provide a comprehensive plan to assist faculty, tutors, learning center personnel and others engaged in the effort to make basic concepts of arithmetic and algebra comprehension for learning disabled students. The handbook includes: (1) a description of the course for which this curriculum was designed including learning objectives; (2) faculty training materials including, a survey of faculty knowledge and attitudes regarding LD students, a list of the effects of learning disabilities, suggested teaching strategies and course requirement adjustments, sample problems which include task analyses which enumerate the concepts, skills, and strategies involved in each problem, and a discussion of the problems and strategies associated with testing LD students; (3) tutor training materials which include an agenda, suggested teaching methods, and evaluations of the student by the tutor and of the tutor by the student; (4) student workshop materials; (5) computer software listings and evaluation sheets; (6) videotape listings and evaluation sheets; and (7) evaluation checklists. Appendices include a list of 43 references, a list of selected information resources, and descriptions of project materials. (CW)

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Teaching Remedial Mathematics to Students with Learning Disabilities

Juliana Corn, *Project Director*
Alexandra Klein, *Learning Disabilities Specialist*
Merrill Parra, *College Coordinator*

Editors:

Juliana Corn
Alexandra Klein
Sandra P. Peskin
Katherine Rangos

This handbook was made possible through a three-year demonstration grant from the U.S. Department of Education Grant G008630155-88

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Project Staff

A DEMONSTRATION PROJECT TO TEACH REMEDIAL MATHEMATICS
TO STUDENTS WITH LEARNING DISABILITIES

Dr. Juliana Corn, *Project Director*
Ms. Alexandra Klein, *Learning Disabilities Specialist*
Mrs. Merrill Parra, *College Coordinator*
Mr. Charles Prancl, *Audio-Visual Specialist*
Dr. Joseph Bertorelli, *CAI Specialist*
Dr. Shailaja Nagarkatte, *CAI Specialist*
Mr. Reuvain Zahavy, *CAI Specialist*
Dr. Jacob Applerman, *Faculty*
Professor Helen Blecher, *Faculty*
Mrs. Toni Kingston, *Faculty*
Mrs. Sandra Peskin, *Faculty*
Dr. Helga Schwartz, *Faculty*
Mrs. Geraldine Duplatre, *Secretary*
Mrs. Muriel Smith, *Secretary*

Consultant
Mr. Elliot Rosman, *Director of Disabled Students Services*

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TABLE OF CONTENTS

I OVERVIEW
Introduction 4
Characteristics of Learning Disabled College Students 6

II COURSE DESCRIPTION
Curriculum Modification for Learning Disabilities Math Project 7
Basic Mathematical Skills (MA-010) Syllabus—
Course Outlines for First and Second Semesters 8

III FACULTY TRAINING
Introduction 10
Faculty Training Agenda 11
Survey of Faculty Knowledge and Attitudes Towards LD Students 12
Effects of Learning Disabilities on Mathematics 15
Teaching the LD Student in the Mathematics Classroom:
Faculty Guidelines 17
Course Requirements 18
Getting LD Students to Participate in the Learning Process 21
Strategies for Teaching Mathematics to Students with
Learning Disabilities 22
Teaching Guide and Sample Problems 25
Suggestions for Testing Learning Disabled
Students in Mathematics 38
Evaluation of In-Service Training 40

IV TUTOR TRAINING
Introduction 41
Tutor Training Agenda 42
Suggestions for Tutors 43
Tutor Evaluation of Student 44
Student Evaluation of Tutor 46

V WORKSHOPS
Introduction 47
Suggested Topics for Student Workshops 47
Sample Student Workshops
Keeping a Mathematics Notebook 48
Survey of Math Study Skills 49
Using Supplementary Instructional Services 50
Final Exam: Study Suggestions 51
Student Workshop Evaluation Checklist 52

VI SOFTWARE
Introduction 53
Review of CAI 54
CAI Review Form 58
Checklist of Software Features 59
Student Evaluation of Computer Software 61

VII VIDEOTAPES
Making Interactive Instructional Videotapes 63
Videotapes 65
Evaluation of Videotape 69

VIII EVALUATIONS
Student Evaluation of Instructor 70
Teacher Evaluation of Tutor 71
Student Satisfaction Questionnaire 72

IX APPENDIX
Selected References 73
Selected Resources 76
Project Materials 79
Order Form 82

I
OVERVIEW

BY JULIANA CORN, PH.D., *Project Director*

INTRODUCTION

This handbook has been developed as one of the objectives of a three-year federally-funded model project to teach remedial mathematics to community college students with learning disabilities.

The underlying theme of the handbook is to provide a comprehensive plan to assist faculty, tutors, learning center personnel and others engaged in the front-line battle to make basic concepts of arithmetic and algebra comprehensible to students with learning disabilities. There are also many other students who exhibit LD characteristics and difficulties, who are not formally diagnosed as such, who would benefit from these strategies.

This handbook contains information aimed at helping students to:

- Understand and apply algorithmic procedures;
- Interpret problems and questions correctly;
- Choose appropriate strategies for solving problems;
- Translate word problems into symbolic representation;
- Check answers in a manner appropriate to the problem;
- Organize work in a written form which is clear and efficient;
- Understand the rules of logic;
- Observe patterns and relationships;
- Generalize problem-solving strategies from one example to another;
- Develop compensatory strategies.

Classroom teachers are frequently frustrated by research articles which discuss prominent theories of learning, but do not descend to "nitty-gritty" issues, such as, "but how do you get the student to understand adding of signed numbers?" As part of the curriculum modification for this project, 370 examples were chosen from arithmetic and elementary algebra to illustrate each basic concept and rule that would be taught in a typical remedial course in a community college. A task analysis was done on each problem, including its description, concepts embedded within it, prerequisite and general skills required to do it, introductory and motivational ideas, and strategies which would be helpful to compensate for student deficiencies and learning difficulties. Sample problems from the task analysis appear in this handbook on pages 25-37. The complete task analysis, titled *A Guide for Teaching Remedial Mathematics to Community College Students*,

is available as a separate publication. It is hoped that faculty and tutors who work with students who experience great difficulty in mastering mathematics will find these ideas useful not only as presented, but as a spark to generate their own creative approaches to teaching.

Similarly, fifty videotapes were created for supplemental use by students taking the remedial course. The principles and techniques underlying the development of these tapes are put forth in another section of this handbook, so that those faculty interested in creating their own interactive videos may use the strategies as a model and improve upon them. Certainly, the ideas discussed will enable faculty to be more critical of available commercial video materials. A complete list of the videotapes produced by the project is given (see pages 65-68), together with directions for purchasing them at nominal cost (see page 82).

Another significant aspect to the project was a survey of currently available computer-assisted instruction (CAI) software with the view to selecting materials to be used by the students for additional reinforcement. Hundreds of hours of software were evaluated by the project's staff, using a comprehensive checklist of characteristics related to content, style, presentation and user-friendliness. This handbook contains a discussion of the criteria for good software, as well as the checklist used and a list of commercial software found to be useful for learning disabled students. In addition, the project's CAI staff created a number of software packages, which are listed on page 80 and available at nominal cost. The complete CAI report, which is too lengthy to be included here, is available upon request.

Other components of the project's multi-faceted approach are discussed in a series of short essays and "how-to" lists. These include characteristics of learning disabled students, encouraging student participation in the classroom, training peer tutors and new faculty to work with students with learning disabilities, individualizing instruction in a traditional classroom setting and testing in alternate modes. A number of evaluation checklists are also included, as an aid to those planning structured support programs for learning disabled students.

Lastly, the resource section contains listings of suggested readings and organizations which provide assistance to the learning disabled. An order form listing project materials and prices (covering mailing and handling costs only) is at the back of this handbook.

This handbook should be used the way good cooks use a cookbook—as a source of information and as an inspiration to alter, improve, and create new strategies to satisfy the learning needs of our students. All the materials in this publication may be duplicated freely for use by nonprofit institutions.

CHARACTERISTICS OF LEARNING DISABLED COLLEGE STUDENTS

- Weakness in one or more of the following areas: Math, Reading, Writing, Oral Language, Spelling, Handwriting
- Poor self-esteem
- Inappropriate social behavior
- Impulsivity
- Attention disorders
- Poor listening skills
- Inconsistent performance
- Poor recall
- Failure to memorize basic number facts
- Test anxiety
- Disorientation in time
- Disorganization
- Poor notetaking skills
- Poor study skills
- Passive learning styles
- Difficulty following directions
- Poor vocabulary
- Confusion of mathematical symbols
- Difficulty shifting from one task or operation to another
- Poor handwriting, letter and number formation
- Difficulty aligning numbers
- Poor strategies for monitoring errors

II
COURSE DESCRIPTION

CURRICULUM MODIFICATION FOR LEARNING DISABILITIES MATH PROJECT

The curriculum of MA-010, Basic Mathematical Skills, a remedial mathematics course taken by students whose placement test scores upon admission indicate they need remediation, was modified to reflect the needs and characteristics of the learning disabled student. The time frame of the traditional one-semester syllabus was stretched to two semesters—twice the time—so that the student would have massive amounts of repetition, practice, feedback, and reinforcement for each concept and skill.

A typical syllabus follows. Although a specific textbook is listed, other teachers in the project were free to use other books. In all cases, the arrangement and sequencing of the topics emphasized the logical connections linking one concept to the next.

The textbooks used in the project were chosen because of certain pedagogical features. They all had simple, uncluttered designs and used easy-to-read typefaces, which made them visually appealing and easier to use. The textbooks had readable explanations and clearly detailed examples; most importantly, they had numerous graduated exercises.

COURSE NAME

MA-010. BASIC MATHEMATICAL SKILLS (First Semester).
5 class hours, 0 credits

TEXT

Basic College Mathematics: An Applied Approach (3rd Edition) by
Richard N. Aufmann and Vernon C. Barker, Houghton Mifflin Co., Boston, 1987

OBJECTIVES

To provide students with arithmetic and algebraic skills necessary for credit-bearing courses. These skills include whole numbers, decimals, fractions, percents, ratio and proportion, signed numbers, order of operations, and linear equations.

Topics	Chapter	Sections	Hours
• Whole Numbers	1	2.1-2.2, 3.1-3.2, 4.1-4.2, 5.1-5.3	4
• Exponential Notation	1	6.1	1
• Order of Operations	1	6.2	2
• Prime Numbers & Factoring	1	7.1-7.2	2
• Fractions	2	3.1-3.2,4.1,5.1 1.1-1.2,4.2,5.2 2.1-2.2,3.2,4.1-4.3 5.3,6.1-6.2,7.1-7.2 8.1-8.3	7
• Decimals	3	1.1-1.2,2.1,3.1,4.1, 5.1,6.1-6.3	5
• Ratio & Proportion	4	1.1,2.1-2.2,3.1-3.3	4
• Percent	5	1.1,1.2,5.1	5
• Geometry	10	1.1-1.2,2.1-2.3,3.-3.3	4
• Signed Numbers	11	1.1-5.1	8
• Variable Expressions	12	1.1-1.3	6
• First Degree Equations	12	2.1-2.3,3.1,4.1-4.2	12
• Verbal Problems*	12	5.1-6.1	6
• Exams			4
TOTAL			70

* Additional problems will be selected from *Introductory Algebra* by Aufmann & Barker, Chapter 3, Section 4.2, and Chapter 4, Sections 7.1-8.1.

COURSE NAME

MA-010. BASIC MATHEMATICAL SKILLS (Second Semester).
5 class hours, 0 credits

TEXT

Introductory Algebra: An Applied Approach (2nd Edition) by
Richard N. Aufmann and Vernon C. Barker, Houghton Mifflin Co. Boston, 1987.

OBJECTIVES

To continue the development of algebraic skills, including equations, verbal problems, polynomials, graphing, factoring, algebraic fractions, and quadratic equations.

Topics	Chapter	Sections	Hours
• Review:			
Algebraic Expressions	2	1.1-3.3	3
Equation Solving	3	1.1-4.1	
Number Problems			
• Literal Equations	7	7.1	4
• Geometry Problems	4	7.1-7.2	4
• Polynomials	5	1.1-4.2	9
• Graphing Linear Equations	8	1.1-1.2,2.1-3.1	8
• Systems of Linear Equations	9	1.1-3.1	6
• Factoring	6	1.1-4.1	12
• Quadratic Equations	6	5.1-5.2	4
• Algebraic Fractions	7	1.1-3.2	12
• Fractional Equations	7	5.1-6.1	4
• Exams			4
TOTAL			70

III
FACULTY TRAINING

INTRODUCTION

Faculty participated in training sessions prior to the school year and in ongoing weekly consultations with the learning disabilities specialist. Training emphasized the characteristics and special needs of students with learning disabilities, especially as they affect performance in mathematics.

Familiarity with these characteristics helped the classroom teachers to anticipate potential difficulties and to adopt appropriate compensatory teaching methods. Awareness of differences in teaching and learning styles enabled the faculty to expand their repertoire of approaches to each mathematical topic in order to provide all students with an adequate opportunity to learn.

A faculty training agenda developed by the project's learning disabilities specialist follows, together with essays and materials which illustrate some of the agenda's salient features.

Faculty Training Agenda

BY ALEXANDRA KLEIN

I. Survey of Faculty Knowledge and Attitudes Towards LD Students *(page 12)*.

II. What Are Learning Disabilities?

   A. Definition.

   B. Videotape: *I'm Not Stupid*, Gannett Co, Inc., 1987 *(page 74)*.

   C. Characteristics of LD students and effects on mathematics performance *(page 15)*.

III. Variations in Learning and Teaching Styles in Mathematics

IV. Teaching the LD Student in the Mathematics Classroom: Faculty Guidelines *(page 17)*.

   A. Clarify course structure and requirements *(page 19)*.

   B. Structure each class session.

   C. Encourage independent, active participation in the learning process *(page 21)*.

   D. Teaching Guide *(page 24)*.

   E. Evaluating student progress *(page 38)*.

V. Course Modifications and Project Structure

VI. Use of Support Services and Materials

VII. Evaluation of In-Service Training *(page 40)*.

Recommended Reading:

Loviglio, Lorraine. 1981. "Mathematics and the Brain: A Tale of Two Hemispheres." *The Mathematics Teacher*, January/February, 8-12.

Levy, Jerre. 1983. "Research Synthesis on Right and Left Hemispheres: We Think With Both Sides of the Brain," *Educational Leadership*, January, 66-71.

Levine, Melvin. 1988. "Learning Disability . . . What is It?" *ACLD Newsbriefs, 173*, 15-18.

Survey of Faculty Knowledge and Attitudes Towards LD Students*

Name: _____ Date: _____

(1) Previous interaction with persons known to have a learning disability.

☐ Yes ☐ No

If yes, check type: ☐ Professional ☐ Personal

(2) Acquired information about learning disabilities. ☐ Yes ☐ No

If yes, check type:

☐ Reading ☐ Media ☐ Coursework ☐ In-Service ☐ Other

(3) Teaching experience at Queensborough Community College:

☐ 0-5 years ☐ 6-10 years ☐ 11-15 years

☐ 16-20 years ☐ Over 20 years

SURVEY ITEMS

Read the statements below and respond by circling the *one* response which best represents your opinion using the following scale:

1 = Strongly Agree
2 = Agree
3 = Tend to Agree
4 = Tend to Disagree
5 = Disagree
6 = Strongly Disagree

(1)	It is unfair to spend more money educating learning disabled students than other students.	1 2 3 4 5 6
(2)	Classroom environments are enriched by the presence of learning disabled students.	1 2 3 4 5 6
(3)	Learning disabled students tend to feel sorry for themselves.	1 2 3 4 5 6
(4)	Learning disabled people have fewer employment opportunities than other adults.	1 2 3 4 5 6

* Based upon a survey instrument developed by PSIMLD-University of Nebraska-Lincoln, Lincoln, Neb. 68583

(5)	I believe that interaction with learning disabled students could be very rewarding.	1 2 3 4 5 6
(6)	I feel uncomfortable around disabled people.	1 2 3 4 5 6
(7)	Learning disabled persons are also mentally retarded.	1 2 3 4 5 6
(8)	All of us are disabled to some degree.	1 2 3 4 5 6
(9)	Learning disabled people take more from society than they give back.	1 2 3 4 5 6
(10)	Learning disabled people should be exempt from some postsecondary graduation requirements.	1 2 3 4 5 6
(11)	Unique problems exist for each learning disabled student which must be carefully taken into account for the learning process to be successful.	1 2 3 4 5 6
(12)	Few learning disabled students will succeed in college.	1 2 3 4 5 6
(13)	A learning disabled student wanting to pursue a professional career should be discouraged from doing so.	1 2 3 4 5 6
(14)	Having learning disabled students in the classroom takes away from the quality of education other students receive.	1 2 3 4 5 6
(15)	It is acceptable to spend additional funds to make this university accessible to learning disabled students.	1 2 3 4 5 6
(16)	Learning disabled students should not be considered handicapped.	1 2 3 4 5 6
(17)	Learning disabled students often are perceived as irresponsible when in reality the problem may be a result of poor organization.	1 2 3 4 5 6
(18)	Poor writing and spelling skills are frequent problems faced by learning disabled students.	1 2 3 4 5 6

(19)	This university has special programs for learning disabled students.	1 2 3 4 5 6
(20)	Learning disabled students should be allowed to utilize taped books, notetakers and/or untimed tests.	1 2 3 4 5 6
(21)	To be realistic, postsecondary education standards should be different for learning disabled students.	1 2 3 4 5 6
(22)	Poor academic performance of learning disabled students is most likely a result of study habits.	1 2 3 4 5 6
(23)	I can recognize a learning disabled student.	1 2 3 4 5 6
(24)	I know when to provide assistance to learning disabled individuals.	1 2 3 4 5 6
(25)	Support services for learning disabled students at the postsecondary level tend to delay development of self-reliance and independence.	1 2 3 4 5 6
(26)	An adapted education program for learning disabled students may not eliminate academic failure.	1 2 3 4 5 6
(27)	It is possible to effectively teach a learning disabled person at the college level.	1 2 3 4 5 6
(28)	I know how to offer assistance to learning disabled individuals.	1 2 3 4 5 6
(29)	I know where to refer learning disabled students for help at this university.	1 2 3 4 5 6
(30)	Learning disabled students at the postsecondary level are protected from discriminatory educational practices by federal law.	1 2 3 4 5 6
(31)	All learning disabled students will respond to the same method of instruction.	1 2 3 4 5 6

Effects of Learning Disabilities on Mathematics

BY ALEXANDRA KLEIN

AREA OF DIFFICULTY	SAMPLE BEHAVIORS
Selective Attention	• Appears not to be trying • Is distracted by irrelevant stimuli • Tunes in and out • Fatigues easily when trying to concentrate
Impulsivity	• Seeks shortcuts • Works too quickly • Makes many careless errors • Doesn't plan strategically • Is easily frustrated • Good at concepts but impatient with details • Calculates imprecisely • Doesn't at end to or omits symbols
Perseveration	• Has difficulty shifting from one operation or step to another
Inconsistency	• Can solve problems one day but not another • Capable of great effort when motivated
Self-Monitoring	• Doesn't check work • Can't pinpoint areas of difficulty • Doesn't review previous tests
Language/Reading	• Has difficulty acquiring math vocabulary • Confuses "divided by" / "divided into," "hundreds" / "hundredths," "LCM" / "GCF," the noun "factor" / the verb "factor," "4 less x" / "4 less than x," "before" / "after," "more" / "less" • Processes oral or written language slowly • Can't name or describe topic ("it has x's") • Has difficulty decoding math symbols

Spatial Organization	• Has difficulty organizing work on page • Doesn't know which part of problem to focus on • Has difficulty plotting points • Loses things • Has difficulty organizing notebook • Has poor sense of direction
Graphomotor Skills	• Forms numbers, letters, and angles poorly • Aligns numbers improperly • Copies incorrectly • Needs more time to complete work • Can't listen while writing • Works more accurately on blackboard than on paper • Prints instead of using cursive script • Produces messy work, crosses out instead of erasing • Has awkward pencil grip • Writes with eyes very close to page
Memory	• Hasn't memorized multiplication facts • Experiences test anxiety • Lacks strategies for storing information • Can remember only one or two steps at a time • Rotates numbers or letters • Reverses sequence of numbers or letters • Has difficulty remembering sequence of algorithms, seasons, months, etc.
Orientation in Time	• Has difficulty with time management • Forgets order of classes • Arrives very early or late to class • Has difficulty reading analog clock
Self-Esteem	• Believes that no amount of effort will lead to success • Denies difficulties • Is very sensitive to criticism • Resists or refuses help
Social Skills	• Doesn't pick up on social cues • Is overly dependent • Doesn't adjust conversation according to situation or audience

Teaching the LD Student in the Mathematics Classroom: Faculty Guidelines

BY ALEXANDRA KLEIN

CLARIFY COURSE STRUCTURE AND REQUIREMENTS

(1) Provide syllabus with explicit instructional objectives and requirements.

(2) Clarify expectations and grading procedures.

(3) Emphasize office hours orally *and* in written form. Encourage students to make an appointment to discuss any difficulties for which they will require special accommodations.

(4) Acquaint students with structure and use of textbooks.

(5) Stress student responsibility.

STRUCTURE EACH CLASS SESSION

(1) Begin each session with a summary of the previous lesson and an overview of the new topic.

(2) Write the date, topic to be covered, and homework assignment on the board for students to copy at the beginning of each session.

(3) Help students with notetaking by writing steps for procedures on the board.

(4) Summarize the lesson at the end of class.

ENCOURAGE INDEPENDENT, ACTIVE PARTICIPATION IN THE LEARNING PROCESS

(1) Include class participation in the criteria for grading.

(2) Encourage students to put homework problems on the board.

(3) Let students know they will be called upon to answer questions. First ask a question, and then call upon a particular student to answer.

(4) Help students develop strategies for monitoring errors.

PRINCIPLES OF REMEDIAL TEACHING

(1) Clarify all relevant vocabulary. Be consistent in use of language to describe procedures. Avoid lengthy, complex sentence structure.

(2) Help students to develop strategies for memorization and recall.

(3) Provide sufficient opportunities for practice.

(4) Review previously learned material. Include previous topics in homework assignments.

(5) Provide visual cues. Use techniques such as color coding, underlining, and boxing to call attention to exponents, variables, operational symbols, etc.

(6) Vary activities and method of presentation.

(7) Be aware of differences in learning and teaching styles. Teach concepts and applications as well as algorithms.

(8) Provide concrete examples common to students' experiences.

(9) Help students to avoid common pitfalls. Be explicit.

(10) Be flexible!

TESTS AND QUIZZES

(1) Give frequent cumulative quizzes.

(2) Analyze errors. Look at process as well as product.

(3) Clarify instructions. Minimize reading requirements.

(4) Vary format of questions.

(5) Provide study guides.

Course Requirements

Following are the requirements distributed by the instructor, Mrs. Toni Kingston, to her Fall 1988 class in Basic Mathematical Skills, MAD-010DH:

(1) **ABSENCES**

It is ***very*** important that you attend all class meetings. If you miss a class, not only do you miss the work that was covered at that class, but you also might have trouble following the classwork when you return. If you ***must*** miss a class, please call one of your classmates:

- to find out what was taught that day and to arrange to get the notes;
- to get the homework assignment; and
- to find out if a test (or quiz) was announced.

Please get the telephone numbers of at least two (2) classmates today so that you will have somebody to call in case you must be absent.

(2) **HOMEWORK**

Homework will be given every time that the class meets. It is ***due*** at the ***next*** class meeting and must be done before you come to class. If you had any trouble doing your homework, you must know ***which*** problems you had trouble with. The best thing to do is to write down the numbers of the problems that you had that day. Also, you may do your homework in groups with your classmates and you may get help with your homework from your tutor. ***You should*** check your answers (to the odd numbered homework problems) in the back of the textbook in order to be sure that you are doing the problems correctly.

(3) **TUTORS**

We will have three (3) tutors in the classroom during the second hour of our Friday class each week. Both the tutors and I will help you with any problems that you are having with the work. Also, each of you will meet with your tutors (in small groups) once a week outside of the classroom. You should ***always*** be prepared to tell your tutor which ***problems*** you are finding difficult.

(4) **QUIZZES**

Quizzes will be given on a regular basis. Each quiz will last approximately 20 to 30 minutes. The dates of the quizzes will always be announced ahead of time. The ***grades*** on the quizzes will only be counted if they will ***raise*** your average. The ***main purpose*** of the quizzes is to see where you are having difficulties so that we can work on eliminating these difficulties ***before*** the regular test.

(5) **TESTS**

There will be approximately seven (7) tests given during the semester. You will receive a review sheet before each exam. You will be expected to do all the problems on the review sheet in order to prepare for the exam. You may get help from your tutor with any problems that you are finding difficult.

(6) **TEXTBOOKS**

Please bring your textbook to class every day.

(7) **FINAL EXAM**

There will be a final exam at the end of the term. It will cover ***all*** the work that was taught during the term.

(8) **GRADES**

Ninety percent (90%) of your final grade for this course will be based on your test grades, your final exam grade, and your quiz grades (if they will raise your average). Ten percent (10%) of your final grade will be based on your classwork. This includes having your homework done on time and class participation (answering questions, etc.). (Note: The grades for this course are P [PASS] or R [REPEAT]).

(9) **NOTES**

You should copy all notes from the blackboard.

(10) **OFFICE HOURS**

My Office Hours are:
Tues., 12-12:50 p.m.
Wed., 10:30-11:00 a.m. and 3:00-3:50 p.m.
Thurs., 3:00-3:30 p.m.

My office is in Room S-231.

Getting LD Students to Participate in the Learning Process

BY JACOB M. APPLEMAN, PH.D.

It is well known that LD students often have difficulty maintaining attention, and have a tendency towards a passive learning style. It is therefore essential to vary the activities in the classroom, so that the students can redirect their attention often. It is also necessary to devise means for the students to be actively involved in what is taking place. This can be difficult, since LD students may be reluctant to participate for fear of being ridiculed or appearing "stupid." During the year that I taught an LD class, I used strategies adapted from my regular classes to accomplish these goals.

It is extremely important for the students to feel "comfortable" with their instructor. This means that the teacher should try to be as supportive, caring, and friendly as possible with the students, while still maintaining the teacher-student status. If this feeling is achieved, it will be relatively easy to get the students to gradually participate more and more in the learning process. The teacher can begin, for example, by asking for volunteers to orally answer an easy question. A right answer should be encouraged, and a wrong one should be gently analyzed to see what oversights it may incorporate. If no one volunteers to answer, the teacher should tell the students not to worry at all if they answer incorrectly—the class as a whole will participate in figuring out how to modify the answer to make it correct. This give-and-take by itself serves as a variation of activity to redirect attention. Of course, the teacher can then employ the traditional methods of varying activity, such as having students work at their seats and going around checking their progress.

An activity I encouraged in all my classes, and one which is especially important for LD students, is having the students go up to the board to put up homework or classwork. When introducing this activity to the class, the teacher should first check the students' work in their notebooks, and ask more than one student to put up specific problems the teacher has pre-screened as correct. There may be some hesitation at first, but with some friendly encouragement the teacher should be able to get students up to the board. It is even OK to employ a "gimmick" to get the students up, such as providing different colors of chalk.

In a short time, even reluctant students can be encouraged to join in this activity. Again, if students feel comfortable with the teacher, even incorrect solutions on the board can be "gently" corrected without embarrassment or fear. The teacher can feel a sense of pride when a student who has put up an incorrect solution is still willing to try again. If this activity is made enjoyable, the teacher will soon find that, without being asked to, the students will be putting homework up at the beginning of class while the teacher is taking attendance. I experienced this with my class, and I hope teachers following these suggestions will have the same results.

Strategies for Teaching Mathematics to Students with Learning Disabilities

BY SANDRA PESKIN

Many of the strategies that have been developed to teach mathematics to students with learning disabilities are strategies that could, and in many cases should, be used with all students. One must approach the teaching of learning disabled students with a willingness to accept each student at whatever level in mathematics he or she is at, and to move on from there. Never assume a student already knows a specific topic. Learning disabled students frequently need constant and continuous reiteration and reinforcement of previously taught concepts. The instructor must be willing to encourage questions and to answer any and all questions, no matter how frequently they are asked. The learning situation should be as nonthreatening as possible, and positive reinforcement should be continually provided. An instructor should never "put a student down." He or she must always teach with compassion and empathy for the students and with an infinite amount of patience.

Developmental lessons should be used. The instructor should briefly state what he plans to do. The aim of the lesson or the topic to be covered and a reference page from the textbook should be written and stated. Every step of the lesson must be explicitly explained. The lesson should be summarized both verbally and in written form, and all procedures should be listed with step-by-step instructions. Remember to involve students in the lesson; developmental lessons are not pure lectures. As the lesson is developed, the instructor's work at the chalkboard should be organized and readable, and time should be allowed for the students to copy material from the board into their notebooks.

Visual aids—such as colored chalk, underlining, arrows, and boxing—should be used to help emphasize the concepts that are being developed. Concrete examples, such as money, measurement, people, and things, should be used to help develop concepts before moving to abstract ideas. Since some learning disabled students have short attention spans, activities should be varied during the course of each class meeting.

The instructor should be aware of the individual needs of the students. Learning disabled students may have visual or physical handicaps that require special consideration. Their particular learning disability may also necessitate special consideration. For example, a student who can focus on only one question at a time may need to have a twenty-question test written on twenty separate pieces of paper. A student who is easily distracted may frequently need to be pulled back into the lesson. A student who has difficulty maintaining a vertical format when working through a problem should be encouraged to do all his work on graph paper, using the vertical lines as guidelines.

Learning disabled students frequently need to be shown how to organize all their written and "scrap" work so that it is readable and usable. They should be encouraged to create a set of index cards for reference and study purposes. Each card should contain a single concept, rule, or explanation, a sample problem, and a reference page. Students should be told about mnemonic devices, but should not be required to use them. These devices are helpful to some students and of no assistance to others.

Since learning disabled students frequently have poor retention abilities, constant reiteration and reinforcement are necessary. Spiral homework assignments should always be given, and all directions should be explicit and repeated frequently. Testing should be both informal and formal with no time constraints placed on the students. Tests should be conducted in as nonthreatening an atmosphere as possible, and both cumulative and topic-specific tests should be given.

When teaching students with learning disabilities, one must remember that although many students share the common label, "learning disabled," they are a very diverse population. One must be willing to be flexible and innovative and willing to adapt to the student's individual needs. What works with one student may or may not work with another student. Teaching learning disabled students is both challenging and rewarding. Although the instructor must initially make a very conscious effort to think through his methods, techniques, and strategies of presentation in detail, the various techniques and strategies soon become an integral part of his teaching style. This extra effort is worth it, for nothing is more rewarding than watching as a student realizes that he understands and can work out a problem that he has never been able to do before.

Teaching Guide

BY JULIANA CORN

The sample problems presented below are typical excerpts from *A Guide for Teaching Remedial Mathematics to Students with Learning Disabilities*, a publication of this project. The entire guide is available at nominal cost (see order form on last page of this guide). The materials are intended to focus attention on potential weaknesses of LD students and to offer suggestions for presentation of topics in arithmetic and algebra as well as for remediation of specific difficulties.

The purposes of the "Concepts" and "Skills" categories are to provide an understanding of the concepts embedded in each sample problem, as well as expected prerequisites for a particular topic. These concepts and "preskills" can be used diagnostically to help the teacher determine possible reasons for student errors or difficulties. It is our belief that recognition of potential weaknesses will help teachers present mathematical topics in ways that minimize misunderstanding.

The "Introduction" offers suggestions for presenting each new topic using such techniques as examples common to students' experiences and concrete or pictorial representations. These techniques call upon common strengths and abilities of LD students.

"Strategies" presents additional suggestions such as visual cues and processing techniques, for overcoming common weaknesses on an individual or small group basis.

Sample Problems

FRACTIONS

Problem 1

Add: $\frac{3}{16} + \frac{5}{16}$

and give answer in lowest terms.

Description of Problem

Adding of fractions with same denominators.

Concepts

- Rule for adding fractions:

$$\frac{a}{b} + \frac{c}{b} = \frac{a+c}{b}$$

- Also idea of reducing answer.
- Idea of "lowest terms" as equivalent fraction which has no common factor between numerator and denominator except 1.

Skills

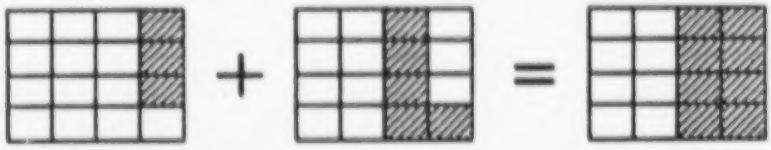
- Ability to distinguish between numerators and denominators.
- Ability to find prime factors of numerator and denominator.
- Ability to divide same factor into numerator and denominator; i.e., "cancellation."
- Understanding of vocabulary: prime factorization.
- Division facts.
- Recognition of prime numbers.

Introduction

Use money: i.e.,

2 dimes + 3 dimes = 5 dimes = ½ dollar

or use boxes:



Strategies

- Identify operations.
- Encircle plus sign.
- First step for addition and subtraction of fractions should be to look at denominators to determine whether they are the same. Have student write same denominator as answer's denominator before dealing with numerators. This initial step should be automaticized at this point to avoid difficulties when fractions with different denominators are introduced.
- Generate rule for division of numerator and denominator by same factor.
- Show organization of work from left to right; e.g.,

$$\frac{8}{16} = \frac{\cancel{2}^{1} \cdot \cancel{2}^{1} \cdot \cancel{2}^{1}}{\cancel{2}_{1} \cdot \cancel{2}_{1} \cdot \cancel{2}_{1} \cdot 2} = \frac{1}{2}$$

Problem 2	Find lowest common multiple (LCM) of: 3, 8, 12.
Description of Problem	Finding LCM of three numbers.
Concepts	• Idea that lowest common multiple is the smallest number that each of the original numbers divides into without remainder. • Idea that LCM contains all prime factors of original numbers, without redundancy.
Skills	• Ability to factor each number into primes. • Ability to use prime factorization to build up LCM via table.
Introduction	Show students how to find LCM of small numbers using multiplication chart.
Strategies	$3 = 3$ $8 = 2 \cdot 2 \cdot 2$ $12 = 2 \cdot 2 \cdot 3$ $3 \cdot \overbrace{2 \cdot 2 \cdot 2}^{8} \cdot \overbrace{3}^{12}$ LCM = 24 • Some students may have learned to find the "LCD." Explain that "LCD" and "LCM" are used in the same way. Define "least" or "lowest," "common" and "multiple" as used here. These words often have little meaning for students, and are therefore easily forgotten or confused. • Have student write down all factors in first number, 3, then check the presence or absence of each factor of the second number, 8, in the tentative LCM, putting in missing factors. Check missing factors of third number, 12, in tentative LCM. Use brackets as shown. It may be helpful to check off factors lightly as student works, to avoid missing or skipping numbers, e.g., $2 \cdot 2 \cdot 2$, not $2 \cdot 2$.

Problem 3

Build an equivalent fraction with the given denominator.

$$\frac{7}{11} = \frac{?}{33}$$

Description of Problem

Finding numerator to build equivalent fraction with given denominator.

Concepts

Idea of equivalent fractions. Rule:

$$\frac{a}{b} = \frac{ac}{bc}$$

Skills

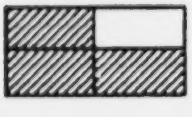
- Ability to divide given denominator by original denominator.
- Ability to multiply numerator of original fraction by missing factor.

Introduction

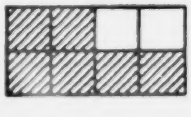
- Using concrete materials, show students that

  $\frac{1}{2} = \frac{2}{4}$ etc.

- Have students come up with other pairs of equivalent fractions using manipulatives only.
- Use boxes to generate equivalent fractions:



$\frac{3}{4}$



$\frac{6}{8}$ etc.

same space with more subdivisions.

Strategies

- See Introduction.
- Generate rule and algorithm for building equivalent fractions.

  $$\frac{7 \times 3}{11 \times 3} = \frac{21}{33}$$

- Explain that multiplication by $\frac{3}{3}$ is equal to multiplication by 1, and therefore does not change the size of the fraction.

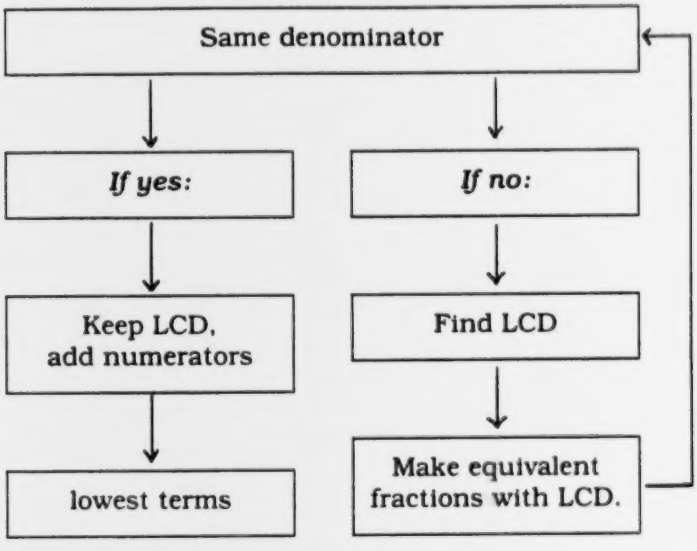
FRACTIONS, *continued*

Problem 4	Add: $\frac{1}{3} + \frac{3}{8} + \frac{1}{12}$
Description of Problem	Adding fractions with unlike denominators.
Concepts	See Problem 1 for rule. • Idea that LCM is the common denominator in the rule. • Idea of building equivalent fractions with LCD (lowest common denominator) as denominator of each fraction. See Problem 3.
Skills	See Problems 1, 2, 3. • Ability to identify denominators as different. • Determine LCD, change each fraction to equivalent one having LCD. • Addition of fractions with like denominators.
Introduction	Use money: 7 nickels + 3 dimes = 7 nickels + 6 nickels = 13 nickels.

Problem 4 continues on next page.

Strategies

- See Problems 1, 2, 3.
  Stress flowchart for decisions:



Arrange work vertically. Use arrows:

$3 \times ? = 24$

$$\begin{array}{rcrcrcl} \frac{1}{3} & + & \frac{3}{8} & + & \frac{1}{12} & = & \\ \frac{?}{24} & + & \frac{?}{24} & + & \frac{?}{24} & = & \end{array}$$

Finding LCD
$3 = 3$
$8 = 2 \cdot 2 \cdot 2$ } $3 \cdot 2 \cdot 2 \cdot 2 = 24$
$12 = 2 \cdot 2 \cdot 3$
Separate procedure

Show multiplications explicitly:

$$\frac{1 \cdot 8}{3 \cdot 8} + \frac{3 \cdot 3}{8 \cdot 3} + \frac{1 \cdot 2}{12 \cdot 2} = \frac{8}{24} + \frac{9}{24} + \frac{2}{24} = \frac{19}{24}$$

DECIMALS

Problem 5	Add: 3.02 + 62.7 + 3.924
Description of Problem	Horizontal addition of mixed decimal numbers.
Concepts	• Place value of whole numbers and decimals. • Understanding of decimals as fractions with denominators as powers of 10.
Skills	• Addition of whole numbers. • Attention to and understanding of decimal point. • Copy and align numbers accurately.
Introduction	Use money sorting— • For example: Place 3 dollars, 2 dimes, and 4 pennies in one pocket; place 5 dollars, 3 pennies in other pocket. Find total amount of money. Do other variations of sorting and adding money. • Idea of sorting and adding dollars, dimes, pennies.
Strategies	It may be necessary for some students to develop a strategy for alignment of numbers according to place value. Such strategies might include: • Use of graph paper or lined paper rotated 90 degrees. • Placement of aligned decimal points prior to writing numbers. • Use of zeroes as placeholders; that is: 3.020 62.700 3.924

SIGNED NUMBERS

Problem 6	Add: (–3) + (–2)
Description of Problem	Addition of two like signed numbers.
Concepts	• Distinction between "sign" of number (i.e., positive or negative) and sign of operation (i.e., addition or subtraction) and use of parentheses. • Idea of addition as process of locating first number on number line, then moving directed distance which represents second number from the first point. • Rule for adding like signed numbers. • Idea of quantity or absolute value of a number and quality or "sign" of a number. • The graphical representation of "signed numbers" on a horizontal number line with "negative" numbers to the left of a "zero" point (origin) and "positive" numbers to the right. (Alternatively, "negative" may be below "zero" and "positive" may be above "zero" on a vertical line.)
Skills	• Ability to locate numbers on number line. • Ability to move specified directed distance from a given point. • Attention to symbols of quality and operation. • Memory of rule.
Introduction	• Introduce idea of negative number. *Examples:* — money owed; — yards lost in football game; — temperatures below zero.
Strategies	• Draw football field and explain in terms of yards gained or lost in succession. • Explain *plus* or *addition* as meaning *and* or *also*. Or use money gained each day as +, money owed as –.

SIGNED NUMBERS, *continued*

Problem 7	Add: 6 + (–5)
Description of Problem	Addition of two unlike signed numbers.
Concepts	• See Problem 6. Also rule for adding unlike signed numbers. • Idea that positive numbers may be written with or without + sign.
Skills	See Problem 6.
Introduction	See Problem 6.
Strategies	• See previous problem. • Have students draw 6 "+" signs for +6, and 5 "–" signs for –5. + + + + + ⊕ – – – – – Line up the symbols so that each pair consists of a + and a – which can be crossed out. What remains is the answer, which is circled.

LINEAR EQUATIONS

Problem 8	Solve: $x + 7 = 5$
Description of Problem	Solving linear equation by subtraction.
Concepts	• Idea of "solution" of an equation. • Idea of checking solution by substituting value into original equation. • Also idea of equation as statement of equality (or balance) between two algebraic expressions. • Idea of "isolating" variable by use of inverse operations. • Idea of maintaining equality or balance between two sides of equation by doing same operation on each side.
Skills	• Attention to equal sign. • Understanding of two sides of equation. • Ability to identify operation joining nume al to variable and knowledge of inverse operation. • Memory of rules for signed number operations. • Ability to evaluate algbraic expressions.
Introduction	• Relate to missing addend problem: $\underline{\quad ? \quad} + 7 = 5.$ • Relate to balance scale or seesaw. In order to maintain balance, same operation must be performed on each side.
Strategies	• Whenever a problem is recognized as an equation to be solved, the variable should be located and underlined or circled so that it can be isolated. • Use arrow over + sign and have student say how "7" is connected to x. • Connect +7 to −7 to emphasize inverse operation: $\underline{x} + 7 - 7 = 5 - 7$

POLYNOMIALS

Problem 9	Simplify: $(x^2 - 2x + 1) - (2x^2 - 5x + 8)$
Description of Problem	Subtraction of polynomials.
Concepts	• Idea of removing symbols of grouping by changing subtraction to addition of opposite-signed polynomial. • Idea that *each* term in the parentheses following the subtraction sign is subtracted; i.e., each sign must be changed. • Idea of removing symbols of grouping and adding like terms.
Skills	• Understanding of "opposite" on a number line; e.g., +3 and −3 are opposites. • Ability to distinguish sign of operation for subtraction. • Ability to identify "terms" and "like terms" of the algebraic expressions. • Memory of rules for signed number subtraction.
Strategies	• Underline each set of like terms with different symbol. • Have − sign in-between two polynomials circled to emphasize subtraction of polynomials. Use arrows to show each term following subtraction is to be changed. $(x^2 - 2x + 1) \ominus (2x^2 - 5x + 8)$

GRAPHING

Problem 10	Graph the ordered pair on a rectangular coordinate system: (2,1).
Description of Problem	Plotting a point in quadrant I of a rectangular coordinate system.
Concepts	Idea of two number lines, one vertical and one horizontal, defining the location of every point in the plane they determine. The intersection is the origin from which you locate the first coordinate on the horizontal line (x-axis), then locate the second coordinate in the vertical (or y) direction. Upper right hand quadrant is quadrant I. (Usual convention, right and up are +, left and down are −.)
Skills	• Ability to locate points on two number lines in proper sequence; i.e., first along horizontal, then vertically from where you are. • Ability to distinguish directions "left of," "right of" (or "below" and "above") a fixed point. • Ability to mark off equal units on a horizontal (or vertical) line. • Ability to count a specific number of units on a horizontal (or vertical) line. • Ability to count a specific number of units away from a fixed point to locate a given number.
Introduction	Talk about meeting a person at the corner of 7th Avenue and 34th Street and then going two blocks east (to the right) and 1 block north (up). Explain you can't meet someone on "34th St." or on "7th Ave." You need both numbers to get the location. Discuss "ordered" pair in the same way.
Strategies	• Review horizontal number line. • Have student put large + on extreme right of line, large − on extreme left. • Have student rotate line counter-clockwise 90° to see a vertical number line with + on top, − on bottom. Then draw intersecting horizontal and vertical lines with origin marked in red. • Have student say aloud the directions— e.g., "2 to the right, then 1 up." • Have student keep one hand on origin, while moving other hand (with pencil) through the direction. • Stress that first coordinate gives distance left-right from origin while second one gives distance up-down from x location. • Use colored chalk or pencil to mark units on axes.

Problem 11	Factor: $2x^2 + 6x + 4$
Description of Problem	Factoring of a polynomial (binomial factors, common factor).
Concepts	• Idea that factoring is the reverse of multiplication or using the distributive law in reverse. • Method of factoring each term separately, then finding GCF of terms as outside multiplier. Remaining factors in each term form terms of the polynomial inside parentheses. • Idea to check for a common factor because x^2 has a non-unit coefficient. Idea of further factoring of polynomial factor into binomial factors. Idea that all factors must be prime for complete factorization. • Idea that a trinomial (3-term polynomial) of the form $ax^2 + bx + c$ may be factored by using a FOIL distributive law structure. When the x^2 term has a coefficient, "1", assume $(x + ?)(x + ?)$. • Idea that the two ?'s represent factors of the constant term which add up to the coefficient of x term. • Idea of checking answer by multiplying factors to get original polynomial.
Skills	• Ability to perform correct sequence of factoring techniques: first, common factoring; then, binomial factoring. • Ability to factor numerical coefficients into primes. • Ability to find all possible pairs of factors for the constant term. • Ability to find algebraic sum of the pairs.
Introduction	• Review prime factorization of number like: $36 = 6 \cdot 6 = 2 \cdot 3 \cdot 2 \cdot 3$. • Discuss idea of doing factoring in partial steps, generalize to algebra. • Review FOIL multiplication.
Strategies	• Have student underline each common factor. All common factors—i.e., those underlined—are the outside multiplier. Any factors not underlined form terms of inside polynomial. • Have student link factors in common factoring with successive steps in binomial factoring with arrows, so that no factors are overlooked: $2(x^2 + 3x + 2) =$ $2(x + 2)(x + 1)$ • Have student divide worksheet into two parts: common factoring and binomial factoring. • Have student set up two columns, headed "multiplies to 2" and "adds to 3." List all factorizations of 2, then sum: $\frac{\text{multiplies to 2}}{1 \cdot 2}$ $\frac{\text{adds to 3}}{1 + 2}$ • Check by multiplying; avoid random guessing.

Problem 12	Solve: $\frac{2x}{3} - \frac{5}{2} = \frac{-1}{2}$
Description of Problem	Solving fractional equation with numerical denominators (single variable term).
Concepts	• Idea of eliminating all denominators by multiplying both sides of equation by LCM (or LCD) of denominators. • Solving resulting equation for x and checking in *original* fractional equation.
Skills	• Ability to identify fractional equation. • Ability to find LCM (see arithmetic, Problem 2). • Ability to distinguish each term in the equation and multiply each term by LCM. • Memory of laws of multiplication of monomials. • Ability to solve linear equation.
Introduction	• Review problems like: $\frac{2x}{3} = 5$ • Discuss idea of multiplying both sides of equation by LCM, as contrasted with multiplying numerator and denominator to make equivalent fraction.
Strategies	• Have student circle = sign to stress this is an equation not an adding of fractions problem. • Have student write each multiplication explicitly, i.e.: $\frac{2x}{3} \cdot \frac{6}{1} - \frac{5}{2} \cdot \frac{6}{1} = \frac{-1}{2} \cdot \frac{6}{1}$ • Have student say rule for arithmetic fraction multiplication aloud and model new problem at the same time. See Problem 8 above.

Suggestions for Testing Learning Disabled Students in Mathematics

BY ALEXANDRA KLEIN

Measuring the progress of learning disabled students, who characteristically perform inconsistently, may be "test-anxious" or simply "don't test well," is bound to be problematic. However, some simple accommodations combined with faculty sensitivity can improve test reliability and enhance student learning as well.

GIVE FREQUENT CUMULATIVE TESTS AND QUIZZES

Ideally, tests or quizzes should be given frequently, and should be cumulative in content. This policy will help the teacher to monitor student progress and to note specific areas of difficulty or misconceptions which can then be remediated. More important, frequent quizzes provide students with feedback on their understanding of specific topics, incentives to study and review, and opportunities to combine new skills with those previously learned. As additional benefits, frequent testing can desensitize anxious students, bolster self-confidence, and provide a greater number of opportunities for success.

PROVIDE STUDY GUIDES

Study guides prepared by the instructor can be of great value to learning disabled students. These may include sample practice problems, key definitions, and specific reminders. Whether students study these review sheets at home or in class, sufficient time should be provided to answer questions which may arise. Study guides need not be identical in nature to actual tests, but should cover all content thoroughly.

PRESENT QUESTIONS IN ALTERNATE FORMATS

To accommodate different learning styles, encourage flexibility, and reward students for divergent as well as convergent thinking, test questions should be presented in various formats. Overreliance on computation questions may exacerbate the tendency of some students to seek an answer by simply "crunching" numbers without understanding the underlying concepts. The following examples of test items illustrate various formats which can be used to supplement computation questions.

- Give an example of a real life situation that would require you to multiply a whole number by a fraction.
- When is it necessary to find a least common denominator?
- Describe the difference between a term and a factor. Give an example of each.
- Construct a flow chart or step-by-step list of procedures for adding signed numbers.
- Make up a quiz of ten questions on the topics covered last week in class. Include an answer key which shows each problem worked out correctly.

AVOID AMBIGUITY

Visual and linguistic clarity—important features of tests for all students—are absolutely essential for those whose learning disabilities may include difficulty processing information. It is advisable to avoid overcrowding the page, and to double check all tests for legibility. Leave adequate space for students to show work, and specify whether students are to indicate their final answers by encircling them, writing them in a designated space, etc. For students with poor perceptual-motor skills, provide an alternative to computer-scored answer sheets. Instructions should be stated as clearly and as simply as possible, avoiding double negatives and overly complex sentence structure.

ESTABLISH APPROPRIATE GRADING PROCEDURES

It is often desirable to include additional criteria for grading. For example, students could be graded for class participation and board work as well as for their performance on examinations. This may more accurately reflect a student's level of mastery, and should also encourage active participation in the learning process. When grading exams, it is important to analyze the process as well as the product and to give partial credit for steps performed properly. In this way, instructors can utilize tests diagnostically to determine specific areas of weakness or confusion. All grading procedures should be established and explained thoroughly when the course begins, and applied consistently throughout the term.

PROVIDE REASONABLE ACCOMMODATIONS

College students with learning disabilities are entitled to "reasonable accommodations" as mandated by Section 504 of the Rehabilitation Act. Such accommodations are not intended to dilute course content, but to help learning disabled students demonstrate more accurately their mastery of the subject matter.

The use of calculators by students who have been unable to master basic arithmetic facts is an accommodation which may facilitate more complicated problem-solving. Instructors who do not interpret calculator use as a "reasonable" accommodation, or who want students to become familiar with arithmetic algorithms, may allow students to use printed charts of addition and/or multiplication facts.

Learning disabled students may require additional time to complete tests and are typically granted up to twice the usual time allotment. On some campuses, these students may take tests individually at the particular institution's office of disabled student services. Another simple accommodation is to allow the use of graph paper (with no more than four squares per inch) by students who have difficulty aligning numerals.

SUMMARY

Our project has found the testing techniques suggested above to be effective for students with learning disabilities. These techniques can be implemented fairly easily by the mathematics instructor who may have little or no experience teaching students with learning disabilities. We hope to assist both instructors and students to recognize the strengths as well as the weaknesses of learning disabled mathematics students.

Evaluation of In-Service Training

Your cooperation in helping us to evaluate our presentation will be greatly appreciated and will help us to plan for future training sessions.

Please check the appropriate number after reading each statement *(4 is the most favorable response; 1 is the least favorable).*

(1) The information presented will be useful to me.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(2) The information presented was well organized and interesting.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(3) The information presented gave me a clearer sense of characteristics of learning disabled math students.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(4) The information presented increased my awareness of program modifications and classroom techniques which can help learning disabled college students to be more successful in math.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(5) The information presented gave me a clearer sense of the role of support services in a program for learning disabled math students.

☐ 4 ☐ 3 ☐ 2 ☐ 1

FILL IN WITH A SHORT ANSWER:

(6) The information I found most helpful was

_____

_____

(7) The information I found least helpful was

_____

_____

(8) I would be interested in learning more about

_____

_____

(9) I am a teacher, administrator, counselor, student, other *(specify)*:

_____

IV
TUTOR TRAINING

INTRODUCTION

Peer tutors were selected for their competence in mathematics, maturity, patience, and compassion. They met weekly with small groups of one to three students, and also spent one class hour each week assisting the teacher in the classroom with a student-tutor ratio of one to five.

The aim of tutor training was to familiarize the tutor with the strengths and weaknesses of their students and to help them to develop strategies for each of their tutees. Tutors were encouraged to use a diagnostic teaching approach to identify the source of each error made by a student in order to develop appropriate intervention strategies.

A tutor training agenda follows, together with suggestions for tutors and sample evaluation forms used by students and tutors to examine the tutoring sessions.

Tutor Training Agenda

BY ALEXANDRA KLEIN

I. Project Overview

II. What are Learning Disabilities?

A. Videotape: *I'm Not Stupid*, Gannett Co., Inc., 1987 *(see page 74)*.

B. Characteristics and common problems of LD college students and their effect on mathematics performance *(see page 15)*.

III. Observation and Analysis of Error Patterns

A. Importance of process as well as product. Suggested resource: patterns of computation errors.

B. Problem-solving approach to remediation of specific errors.

IV Suggestions for Tutors *(see page 43)*.

A. Structuring the tutoring hour.

B. Dealing with student behavior.

C. Principles of tutoring.

D. Helping students with organization and study skills.

V. Suggestions for Students Who Are Not Experiencing Difficulty with Current Topics

A. Work on study skills, notetaking.

B. Solve or invent word problems.

C. Help other students.

VI. Attendance and Record-Keeping Procedures

VII. Evaluation of In-Service Training *(see page 40)*.

Suggestions for Tutors

BY ALEXANDRA KLEIN

STRUCTURING THE TUTORING HOUR

(1) Try to make the most of the allotted time for tutoring. A 50-minute session goes by very quickly!

(2) Take attendance.

(3) Assess student preparation and glance at notes. Ask, "What topic are you studying now?"

(4) Ask for questions, areas of difficulty.

(5) Review homework, review sheets, tests, etc.

DEALING WITH STUDENT BEHAVIOR

(1) Be patient and encouraging.

(2) If you are unsure of an answer, don't be afraid to admit it. Try to help the student find the answer, then ask for help if necessary.

(3) Avoid getting side-tracked by personal problems.

(4) Set limits. You are available for help, not for abuse. In an extreme case, you may ask a student to leave a session.

PRINCIPLES OF TUTORING

(1) Encourage student participation. Ask questions such as, "What is the next step?" or "Why do you have to find the LCD?," rather than "Do you understand?"

(2) Help students to develop self-confidence and independence. Make sure they are working as hard as you are.

(3) Try to determine why the student is making a particular error. Look for patterns.

(4) Begin at earliest point of difficulty and present information in small steps. Provide opportunities for success.

(5) Be generous with praise for good work.

(6) Encourage students to discard unsuccessful approaches to math.

HELPING STUDENTS WITH ORGANIZATION AND STUDY SKILLS

(1) Give suggestions for improving notebooks.

(2) Help students keep note cards with rules and procedures for studying and reviewing.

(3) Insist that students aim for neatness. Those with great difficulty should use graph paper.

(4) Help students develop methods for memorization of information.

Tutor Evaluation of Student

Student Name: _____ Date: _____

PREPARATION

Check YES or NO to indicate whether student is prepared with each of the following:

	YES	NO
(1) Pen or pencil	☐	☐
(2) Text	☐	☐
(3) Notebook	☐	☐
(4) Current notes (including date, name of topic, homework assignment, notes)	☐	☐
(5) Completed homework	☐	☐
(6) Attempted homework	☐	☐

Specific questions or problems *(please list them here)*:

_____

_____

_____

Supplementary materials, such as, times tables, review sheets, tests, etc.

_____

If no, indicate what is missing: _____

ATTITUDE AND BEHAVIOR

Check YES or NO to indicate your answer. Use additional space for comments.

	YES	NO
(1) Actively involved in learning process.	☐	☐
(2) Shows effort.	☐	☐
(3) Positive attitude.	☐	☐
(4) Stays on task.	☐	☐
(5) Works well with other students.	☐	☐
(6) Able to work independently.	☐	☐
(7) Able to focus and sustain attention.	☐	☐

PROGRESS

(1) Does this student seem to be progressing?

(2) Specific areas of difficulty.

(3) What do you think might help this student to improve?

ADDITIONAL COMMENTS:

Student Evaluation of Tutor

Student's Name: _____ Date: _____

Tutor's Name: _____

Directions: Read each statement about today's tutoring session. Check YES or NO to show how you feel about each statement.

	YES	*NO*
(1) My tutor began and ended today's session on time.	☐	☐
(2) My tutor checked my notebook today.	☐	☐
(3) My tutor reviewed homework problems today.	☐	☐
(4) My tutor reviewed for a test or quiz.	☐	☐
(5) My tutor answered my questions.	☐	☐
(6) My tutor was patient.	☐	☐
(7) I feel that my tutor is helping me to do better in math.	☐	☐

If you have any comments about your tutor, please write them here:

_____

_____

_____

_____

_____

_____

PROGRESS

(1) Does this student seem to be progressing?

(2) Specific areas of difficulty.

(3) What do you think might help this student to improve?

ADDITIONAL COMMENTS:

Student Evaluation of Tutor

Student's Name: _____ Date: _____

Tutor's Name: _____

Directions: Read each statement about today's tutoring session. Check YES or NO to show how you feel about each statement.

	YES	NO
(1) My tutor began and ended today's session on time.	☐	☐
(2) My tutor checked my notebook today.	☐	☐
(3) My tutor reviewed homework problems today.	☐	☐
(4) My tutor reviewed for a test or quiz.	☐	☐
(5) My tutor answered my questions.	☐	☐
(6) My tutor was patient.	☐	☐
(7) I feel that my tutor is helping me to do better in math.	☐	☐

If you have any comments about your tutor, please write them here:

_____

_____

_____

_____

_____

_____

V
WORKSHOPS

INTRODUCTION

The needs of remedial mathematics students with learning disabilities are not limited to the acquisition of mathematical skills and concepts. They often need to develop additional competencies if they are to become successful college students.

The transition from high school to college is particularly hard for freshmen with learning disabilities who often have difficulty with organization, time management, and study skills. Students who have been in special education rather than mainstreamed classes in high school may find it difficult to adjust to the demands and responsibilities of college life.

Monthly workshops were held by the learning disabilities specialist to address these concerns. Topics were chosen on the basis of the observations of the entire staff and students' requests. Staff members were encouraged to reinforce strategies presented at the workshops during classes and tutoring sessions.

Suggested topics for student workshops and materials used in actual workshops follow.

SUGGESTED TOPICS FOR STUDENT WORKSHOPS

- Keeping a Mathematics Notebook
- Orientation to College Life
- Math Study Skills
- Time Management
- Using Supplementary Instructional Services
- Working Effectively with a Tutor
- The Mathematics Textbook: Structure and Use
- Becoming an Active Learner
- Self-Monitoring: Identifying Weaknesses and Getting Help
- Developing Listening Skills
- Following Directions
- Final Exam: Study Suggestions

Sample Student Workshops

KEEPING A MATHEMATICS NOTEBOOK

STUDENT WORKSHOP PRESENTED BY ALEXANDRA KLEIN

(1) Why is it important to have a good Math notebook?
How many reasons can you think of? List them here:

_____

_____

_____

_____

(2) Suggestions for taking good notes in Math class.

- Write the date, name of the topic, and homework assignment at the top of the page each day.
- Write explanations in words. Don't just write numbers!
- Write step-by-step instructions for all procedures (list or chart).
- Use different colors, underlining, stars, etc., for important ideas.
- If you have difficulty writing notes during class, use a tape recorder and/or arrange to copy a classmate's notes.

(3) Neatness counts

- Rewrite notes after each class.
- Use a small looseleaf, or keep a separate folder for loose papers and tests.
- Use pencil or erasable pen.
- Clean out your notebook and bookbag each week. Throw out unimportant papers that don't belong in your notes. NEVER throw out old test papers, no matter what grades you received.

SURVEY OF MATH STUDY SKILLS

STUDENT WORKSHOP PRESENTED BY ALEXANDRA KLEIN

(1) Math is different from other subjects because:

_____

_____

_____

(2) When studying for a math test, I find it most helpful to *(check one)*:

- ☐ review class notes
- ☐ read the textbook
- ☐ practice doing problems
- ☐ other: _____

(3) When I have to memorize something, I:

- ☐ write it on my hand
- ☐ read it several times
- ☐ teach it to someone else
- ☐ other: _____

(4) The best place to study is _____

(5) The best time to study is _____

(6) On a test or homework paper, it is important to show all work because

_____

_____

(7) When I have a math problem that I can't solve, I *(check one)*:

- ☐ break my pencil
- ☐ reread my notes
- ☐ go over the sample problems in my textbook
- ☐ ask someone for help
- ☐ other: _____

(8) When I get a math test back from my teacher, I

_____

_____

(9) If my textbook has an answer key, I use it to

_____

_____

USING SUPPLEMENTARY INSTRUCTIONAL SERVICES

STUDENT WORKSHOP PRESENTED BY ALEXANDRA KLEIN

(1) THE INSTRUCTIONAL RESOURCE CENTER
Introduction by Mr. Ury Krotinsky, Director of Educational Technology

(2) COMPUTER SOFTWARE

- Demonstration and care of equipment and diskettes
- Handout: available software for MOD I

(3) VIDEOTAPES

- Using equipment
- Handout: Available videotapes

(4) EVALUATION PROCEDURES FOR CAI AND VIDEOTAPES

(5) EFFECTIVE USE OF TUTORING SERVICES

- Scheduling
- Attendance
- Preparation
- Productive use of time

(6) WORKSHOP EVALUATION

FINAL EXAM: STUDY SUGGESTIONS

STUDENT WORKSHOP PRESENTED BY ALEXANDRA KLEIN

(1) GATHER STUDY MATERIALS

- Notes
- Homework sheets
- Lists of topics
- Tests and review sheets
- Final review sheet

(2) TEST YOURSELF

- Practice doing problems of each type, even those that seem easy.

(3) IDENTIFY WEAKNESSES

- What did you get wrong on tests?
- Which topics are you unsure of?
- Which problems on the review sheet are difficult for you?
- What kinds of careless errors have you made?

(4) GET HELP . . . AND PRACTICE

- See your professor.
- See your tutor.
- Work with other students.
- Look up topic in notes and textbook. Review sample problems and homework problems.
- Ask your tutor to help you make a list of "careless errors" to watch for.
- Use videotapes in Instructional Resources Center of the Library.
- Use software in math computer lab.

(5) WHEN YOU TAKE THE EXAM

- Read directions carefully.
- Look over the whole test before you begin.
- Write important formulas and rules on your test or scrap paper.
- Work at a comfortable pace . . . don't rush or go too slowly.
- Do easier problems first. Save the most difficult for last.
- Check to make sure you have copied carefully.
- Monitor your work for careless errors.

(6) REMAIN CALM.

If you begin to tense up, take five slow deep breaths and continue on.

GOOD LUCK!!! STUDY HARD!!!

Student Workshop Evaluation Checklist

Your cooperation in completing the following workshop evaluation will be greatly appreciated and will aid us in planning future workshops.

Please check the appropriate number after reading each statement *(4 is the most favorable, and 1 is the least favorable).*

(1) The information presented will be useful to me.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(2) The information presented was well organized, interesting, and not a repetition of facts I have learned before.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(3) The information I found most helpful was

_____

_____

(4) The information I found least helpful was

_____

_____

(5) I would be interested in attending future workshops

_____

_____

(6) Please feel free to include any comments or suggestions you may have for future workshops so that we can best meet your needs.

_____

_____

_____

(7) Which of the following topics would you be interested in for future workshops? *(You may check as many topics as you like.)*

☐ Study skills
☐ Preparing for tests
☐ Learning strategies for math
☐ Time management and organization
☐ Problem-solving and thinking skills
☐ Other _____

VI
SOFTWARE

INTRODUCTION

In accordance with our project objectives, members of the project staff identified and reviewed more than 90 mathematics software packages including commercial packages and in-house software developed by other educational institutions.*

Our goal was to select the best available software for our learning disabled students and to create original software packages to supplement each topic in their remedial mathematics course. This course, a noncredit prerequisite to all credit-bearing math courses, includes a total of 21 mathematical topics in arithmetic and elementary algebra.

The commercial software packages listed in this booklet were selected for use following systematic reviews by experienced community college mathematics instructors and by the project's learning disabilities specialist. Evaluation instruments consisted of a three-page checklist of desirable features, a copy of which has been included in this section, and open-ended comments by the reviewers. Mathematical and educational factors as well as characteristics of learning disabled students were considered in the development of evaluation criteria. The ultimate selection process depended primarily upon what are, in our opinion, the most important features. For example, regardless of other favorable characteristics, we did not select software which did not meet our curriculum objectives, or did not meet standards of mathematical correctness, age appropriateness, or motivation. Additional features which we believe to be crucial are step-by-step presentation, a large number of practice problems, minimal reading requirements, immediate feedback and positive reinforcements, and remedial branching.

All software packages selected or created by our project are listed on the following pages. For each package, we have listed purchasing information as well as comments critical to our decision-making process.

We hope this information will be useful to other institutions who are interested in serving similar student populations.

* The complete listing of all software reviewed ("A Review of Computer Software") is available upon request. See order form, page 82.

SELECTED COMMERCIAL PACKAGES

Software	Publisher	Approximate Cost	Comments
Addition w/carrying (9 × 9 table).	Mindscape Educational Software	$29.99	• Provides addition table by pressing H.; 9 × 9 table • Information presented step-by-step. • Rules stated. • Good practice sets. • User-friendly. • Clear visuals. • Minimum reading requirement.
Subtraction	Mindscape Educational Software	$29.99	• User response open-ended. • Gives hints specific to incorrect responses. • High user control. • Strong motivation.
1, 2, 3, Digit Multiplication	Mindscape Educational Software	$29.99	• Provides multiplication table by pressing H.; 9 × 9 table (in both multiplication and division software).
Long Division	Mindscape Educational Software	$29.99	• User may select 1, 2, or 3 digit divisors and answers with or without remainders. • Step-by-step responses required, not just final answers.
Adding Fractions Subtracting Fractions	Mindscape Educational Software	$29.99	• Step-by-step sample problem. • Student response required. • Vertical format. • Choice of up to nine problems randomly generated. • Additional sets of 9 available for student. • 2 errors at a given step elicits correct next step. • Correct answer rewarded.

Software	Publisher	Approximate Cost	Comments
Multiplying Fractions Dividing Fractions	Mindscape Educational Software	$29.99	• Cancellation must be done before multiplying (good method). • Fractions only given in improper form, not mixed number form. • Mathematically sound treatment. • Good level of user-friendliness. • Clear text, minimal reading required. • "Invert Divisor" is explained intuitively. • You can review sample problems any time.
Adding Decimals Subtracting Decimals Multiplying Decimals Dividing Decimals	Mindscape Educational Software	$29.99 each	• Step-by-step instruction. • Student must input each step including lining up decimals (addition and subtraction), placement of decimal point (multiplication and division) and performing operations. • Significant user control (number of practice problems, amount of digits in each number, with or without carrying, borrowing, etc.) • Provides feedback, reinforcement, remedial branching. • Flashing cursor directs attention.
Equations Level I Equations Level II Equations Level III	Mindscape Educational Software	$29.99 each	• Student inputs each step. • Good explanations. • Random generation of problems. • If response is incorrect, hints given are specific to incorrect answer. • Level I considers $ax + b = c$. • Solutions are all integers, although very large selection (up to 50) of practice problems available. • There is an incorrect use of the word "term." • Level II includes problems of form $ax + b = cx + d$. • Rules and procedures are clearly explained. • User-friendly instructions, on-line help available at any time. • Clear text, good reading level. • Can move freely within program, skip or repeat. • Equations Level III includes parentheses, combining like terms.

Software	Publisher	Approximate Cost	Comments
Factoring Algebraic Expressions	Mindscape Educational Software	$29.99	• Randomizes problems. • Good explanations, clear language. • Step-by-step solutions. • Remedial branching. • Hints specific to incorrect response.
Quadratic Equations	Mindscape Educational Software	$29.99	• Information presented correctly, in step-by-step manner. • Rules clear but somewhat wordy. • Sufficient practice. • Moderately user-friendly. • Clear text but reading requirement not minimal. • Immediate positive reinforcement for correct answers. • Remedial branching provides specific hints for incorrect responses. • Open-ended user response. • Can move freely in program.
Rational Expressions Disks: I & II; Menu: evaluation, simplification, addition, subtraction, multiplication, division (includes monomial and polynomial denominators)	Courses by Computers P.O. Box 830 State College, PA 16804	$69.95	• Good instructions and explanations. • Helpful hints given after incorrect responses. • Multiplication problems leave reducing to the end. • Good tutorial material.
Math Practice and Problem Solver Includes 10 diskettes: ***Arithmetic Series:*** 1. Whole Numbers 2. Decimals 3. Fractions 4. Percentage ***Algebra Series*** 1. Signed Numbers 2. Polynomials 3. Simple Equations and Inequalities 4. Simple Graphing (requires graphic card) 5. Factoring Algebraic Expressions 6. Simultaneous and Quadratic Equations	H and N Software P.O. Box 4867 Bricktown, NJ 08723	Contact publisher	• User may choose between two modes. • Practice Mode presents at least 20 graded problems for each topic. • No initial tutorial presented. • Problems are worked out on paper and only solutions are entered. • No hints or remedial branching. • Step-by-step solution provided for incorrect responses. • Screen sometimes overcrowded. • Problem Solver Mode, which allows user to enter own problem, is somewhat difficult to use.

IN-HOUSE SOFTWARE DEVELOPED BY PROJECT STAFF

Software / Author	Publisher	Cost	Comments
Review of MOD II *Author:* Dr. Shailaja Nagarkatte *Includes:* Algebraic Expressions, Integers and Signed Numbers, Introduction to Geometry	LD Project Department of Mathematics Queensborough Community College	$5.00	**Review of MODs II, III, and IV.** • Incorrect answers represent common errors. • Remedial branching provides feedback to incorrect responses. • User may request hints. • Provides immediate feedback and positive reinforcement. • Clear visual display, user friendly. • User inputs final answer after working out problem on paper.
Review of MOD III *Author:* Dr. Joseph Bertorelli *Includes:* Solving Linear Equations, Word Problems, Graphing, Systems of Equations	LD Project Department of Mathematics Queensborough Community College	$5.00	
Review of MOD IV *Author:* Mr. Reuvain Zahavy *Includes:* Algebraic Products and Factoring, Algebraic Fractions and Fractional Equations, Quadratic Equations.	LD Project Department of Mathematics Queensborough Community College	$5.00	
Arithmetic Problem Generator for Whole Numbers, Decimals, and Fractions *Author:* Dr. Helga Schwartz	LD Project Department of Mathematics Queensborough Community College	$5.00	• Provides printout of randomly generated problems of a specific type selected from a menu of carefully graded examples. • Answers, but not solutions, provided in separate location so that students may check their work. A good tool for assigning extra practice in areas of difficulty and for review of previously learned material.

CAI Review Form

Date: _____

Reviewed by: _____

Name of Program: _____ Number of Disks _____

If part of a series, indicate series name: _____

_____

Publisher	**Distributor**
Name _____	Name _____
Address _____	Address _____
City, State, Zip _____	City, State, Zip _____
Telephone _____	Telephone _____

Available for _____ computers with _____ memory.

Peripheral Equipment Requirements:

_____

Price of Program: _____ for _____ __ disk(s).

Price of Series: _____ for _____ disk(s).

Program Menu:

(1) _____	(6) _____
(2) _____	(7) _____
(3) _____	(8) _____
(4) _____	(9) _____
(5) _____	(10) _____

General Description of Program:

_____

_____

Comments:

_____

_____

_____

Checklist of Software Features

EDUCATIONAL FACTORS	*Yes*	*Unsure*	*No*	*N/A*
(1) Meets curriculum objectives	☐	☐	☐	☐
(2) Names prerequisite skills	☐	☐	☐	☐
(3) Mathematically sound	☐	☐	☐	☐
(4) Information presented in proper sequence	☐	☐	☐	☐
(5) Step-by-step presentation	☐	☐	☐	☐
(6) Rules/procedures clearly stated	☐	☐	☐	☐
(7) Mathematical vocabulary is explained	☐	☐	☐	☐
(8) Number of practice problems is sufficient	☐	☐	☐	☐

USER FRIENDLINESS				
(1) Operating manual is clear	☐	☐	☐	☐
(2) On-screen instructions are simple	☐	☐	☐	☐
(3) User can begin easily	☐	☐	☐	☐
(4) On-line help available at anytime	☐	☐	☐	☐

(5) List any special equipment or procedures required for operation:

_____

_____

PERCEPTUAL FACTORS				
(1) Clear, readable text	☐	☐	☐	☐
(2) Graphics are helpful, not distracting	☐	☐	☐	☐
(3) Reading requirements are minimal	☐	☐	☐	☐
(4) Screen is not overcrowded	☐	☐	☐	☐
(5) Sound can be turned off/on	☐	☐	☐	☐

PROVIDES FEEDBACK/REINFORCEMENT

(1) Provides immediate positive reinforcement for correct answers	☐	☐	☐	☐
(2) Only correct answers are rewarded	☐	☐	☐	☐
(3) Hints given to encourage correct answer	☐	☐	☐	☐
(4) User response is open-ended	☐	☐	☐	☐
(5) Multiple choice format (Incorrect choices represent common error patterns)	☐	☐	☐	☐
(6) Branching provides hints specific to incorrect responses	☐	☐	☐	☐
(7) Step-by-step solutions given for incorrect responses	☐	☐	☐	☐
(8) If correct, user can request step-by-step solution	☐	☐	☐	☐
(9) Student is informed of success rate	☐	☐	☐	☐

MOTIVATION

(1) Program engages attention	☐	☐	☐	☐
(2) Maintains attention by requesting frequent responses	☐	☐	☐	☐

USER CONTROL

(1) Rate of presentation can be controlled	☐	☐	☐	☐
(2) Can move freely within program (skip or repeat activities)	☐	☐	☐	☐
(3) Can exit at any time	☐	☐	☐	☐

Student Evaluation of Computer Software

Student's Name: _____ Date: _____

Name of software: _____

Please check the appropriate number after reading each statement *(4 is the most favorable; 1 is the least favorable).*

(1) I enjoyed the microcomputer program.
☐ 4 ☐ 3 ☐ 2 ☐ 1

(2) The lesson was presented clearly.
☐ 4 ☐ 3 ☐ 2 ☐ 1

(3) Working with the screen was interesting.
☐ 4 ☐ 3 ☐ 2 ☐ 1

(4) I found myself trying to learn rather than just watching the screen.
☐ 4 ☐ 3 ☐ 2 ☐ 1

(5) I feel satisfied with what I learned.
☐ 4 ☐ 3 ☐ 2 ☐ 1

(6) I would recommend this software to other students.
☐ 4 ☐ 3 ☐ 2 ☐ 1

(7) I would be interested in seeing other software programs.
☐ 4 ☐ 3 ☐ 2 ☐ 1

(8) The software gave hints that were helpful to me.
☐ 4 ☐ 3 ☐ 2 ☐ 1

(9) When I made a mistake the software helped me to understand what went wrong.
☐ 4 ☐ 3 ☐ 2 ☐ 1

(10) The material presented was:
☐ Too difficult for me
☐ Just right
☐ Mostly a review for me

(11) What would you change to make this software better?

(12) What did you really like about this lesson?

VII
VIDEOTAPES

Making Interactive Instructional Videotapes

BY JULIANA CORN, PH.D.

One component of the project was the production of fifty videotapes to be used to enhance and supplement the learning of a remedial mathematics course. The course covers arithmetic and elementary algebra, which involves decoding, encoding, and manipulating abstract symbols, as well as understanding technical language, all of which are difficult for learning disabled students. Mathematics is also a cumulative subject—students who have trouble with the basic ideas find it impossible to cope with later material.

The use of interactive videotapes outside the classroom provides practice and further clarification for the students. The video lesson should embody techniques which address the needs of learning disabled students. Some of the strategies which have been found helpful are:

- Begin with a summary of the previous lesson or a motivational idea and connect it slowly to the new concepts in the lesson.
- Be explicit about the lesson's objective.
- Make mathematical ideas and symbols "real" by using concrete examples from the student's experiences.
- Acknowledge that college students with learning disabilities are *not* children and use appropriate examples and language, even when explaining primitive ideas.
- Use diagrams, flow charts, or manipulative materials, wherever possible, to highlight concepts.
- Use model sample problems, exploring each aspect of the objectives in an intuitive, developmental manner.
- Write every step, however small, on the board, reinforcing it with verbal explanation.
- Use visual cues, such as arrows, colored chalk, boxed or underlined symbols. The various parts of the problem should be clearly delineated.
- Have the camera focus on the part of the problem being explained, so that the viewer is not distracted by the other written material or the general surroundings shown.
- Define all vocabulary and develop explicit rules or algorithms, based on the sample problems.

- Use consistent language throughout the lesson, stressing the same phrases as used in the rules or algorithms.
- Have the formal rules and algorithms appear on the screen, as well as express them verbally. Encourage the student to write the rules on a card or in a notebook for easy reference. Hearing, seeing, *and* writing the rules provide multi-sensory reinforcement.
- Give practice problems, similar to the sample problems, for the student to try throughout the video. "Hands-on" experience encourages the student. Keep passive viewing to a minimum.
- Give immediate feedback, with all the steps shown. Use captions on the bottom of the screen, reiterating key phrases from the rules and algorithms, for further emphasis.

Although these strategies were developed for mathematics instruction, many are applicable to other subjects, particularly those of a technical or scientific nature.

VIDEOTAPES

DEMONSTRATION PROJECT TO TEACH REMEDIAL MATHEMATICS TO STUDENTS WITH LEARNING DISABILITIES

QUEENSBOROUGH COMMUNITY COLLEGE • BAYSIDE, N.Y. 11364 • 718-631-6361

The following videotapes relating to the above project are currently available. They are in ½-inch VHS format and run 45 to 60 minutes.

(1) Adding and Subtracting Arithmetic Fractions

$\frac{1}{2} - \frac{1}{3}$; $\frac{5}{6} + \frac{1}{6}$; $\frac{10}{27} + \frac{5}{36}$

(2) Mixed Numbers and Improper Fractions

$\frac{27}{4} = ?$; $2\frac{1}{3} = ?$

(3) Adding Mixed Numbers

$17\frac{1}{3} + 101\frac{2}{5} + 17\frac{2}{15}$

(4) Solving Linear Equations by Addition and Subtraction

$x + 3 = 7$; $x - 5 = -1$

(5) Solving Linear Equations by Multiplication and Division

$3x = 15$; $-2x = 12$; $\frac{x}{-4} = 7$

(6) Solving Linear Equations: Combined Operations I

$2x + 5 = 7$; $3x - 1 = -10$

(7) Solving Linear Equations: Combined Operations II

$2x + 5 = 7x - 30$

(8) Solving Linear Equations: Parentheses; Simplification

$2x + 3x - 5 = 7x - 7 - 2$; $3(x+5) - 2 = 7(2x + 1)$

(9) Factoring: Common Factors

$2x^2 + 10x$; $3a^3 - 6a^2 + 3a$

(10) Factoring: Trinomials I

$x^2 + 5x + 6$; $x^2 - 5x + 6$

(11) Factoring: Trinomials II

$x^2 + 5x - 6$; $x^2 - 4$

(12) Factoring: Trinomials III

$4x^2 - 9$; $2x^2 + 2x - 24$

(13) Solving Quadratic Equations I

$x^2+5x+6=0$; $x^2-9=0$

(14) Solving Quadratic Equations II

$x^2+5x=6$; $x^2-16=6x$; $2x-5=2x^2-9$

(15) Algebraic Fractions: Reducing, Multiplication, Division

$$\frac{x^2-25}{2x+10}\ ;\quad \frac{x^2+5x+6}{x^2-9}\cdot\frac{5x-15}{5}\ ;\quad \frac{3x+12}{3x+6}\div\frac{2x-10}{2x+4}$$

(16) Adding Signed Numbers

$(+2)+(-5)$; $(+4)+(-3)+(-1)$

(17) Subtracting Signed Numbers

$(-2)-(-5)$; $(+2)-(+3)+(-4)$

(18) Multiplying Signed Numbers

$(+2)(-3)$; $(-1)(-3)(-4)$

(19) Dividing Signed Numbers

$(-6)\div(-2)$; $\dfrac{(-1)(-4)}{(-2)(+2)}$

(20) Signed Numbers: Short Cuts and Order of Operations

$-2+5$; $-2-5$; $2+3\cdot4$; $6-6\div(-2)$

(21) Signed Numbers: Continuation of Order of Operations

$2+3\cdot4^2$; $(-3)^2(5-7)^2-(-9)\div3^2$

(22) Addition-Subtraction of Variable Expressions

$7x+3x+x$; $2ab+3ac-4ab+6ac$

(23) Distributive Law of Multiplication of Addition or Subtraction

$-3(x+4)$; $5x+2(x+7)$; $8(y+2)-3(4y-2)$

(24) Addition-Subtraction of Polynomials

$(2x^2+3x)+(3x^2-x)$; $(3y+7z)-(2y-5z)$

(25) Multiplication of Monomials

$(x^5)(x^3)$; $(-2a^2x^2)(3a^3x^3)$

(26) Division of Monomials

$$\frac{x^5}{x^2}\ ;\quad \frac{28a^2bc}{-4abc^4}$$

(27) Powers of Monomials

$(x^2)^3$; $(2x^3y)^4(-3x^2y)$

(28) Multiplication of Polynomials

$(x^2+5x+1)(x+2)$; $(x+3)(2x+5)$

(29) Systems of Linear Equations: Substitution

$2x + 3y = 9$; $7x + y = 14$

$y = x -$; $2x - 5y = -33$

(30) Systems of Linear Equations: Addition I

$x + y = 15$; $5x + 3y = 8$

$x - y = 3$; $4x - y = 3$

(31) Systems of Linear Equations: Addition II

$3x + 4y = -1$; $9y = 2x + 5$

$2x - 5y = 7$; $5x = 16 - 16y$

(32) Adding and Subtracting Algebraic Fractions I

$\frac{2y+5}{x} + \frac{5y+7}{x}$; $\frac{4x+3}{2x-7} - \frac{3x-8}{2x-7}$

(33) Adding and Subtracting Algebraic Fractions II

$\frac{x}{12} + \frac{5x}{8}$; $\frac{a-2}{2a^2} + \frac{1}{6a}$

(34) Adding and Subtracting Algebraic Fractions III

$\frac{2}{3x+6} + \frac{7}{5x+10}$; $\frac{7}{x^2-16} - \frac{3}{x-4}$

(35) Solving Fractional Equations

$\frac{x}{3} - \frac{2}{3} = \frac{1}{15} - \frac{2x}{5}$; $\frac{1}{3x} + \frac{5}{x} = \frac{2}{3}$

(36) Equivalent Fractions

$\frac{4}{5} = \frac{?}{35}$; $\frac{8}{3} = \frac{?}{24}$; $\frac{35}{25} = ?$

(37) Multiplication and Division of Fractions

$\frac{35}{49} \times \frac{14}{45}$; $\frac{16}{33} \div \frac{4}{11}$; $16 \div \frac{24}{31}$

(38) Subtracting Mixed Numbers

$7\frac{5}{18} - \frac{1}{9}$; $12\frac{2}{5} - 8\frac{1}{2}$

(39) Multiplying and Dividing with Mixed Numbers

$6 \times 5\frac{2}{3}$; $7\frac{3}{5} \times 4\frac{1}{6}$; $1\frac{1}{4} \div 16$

(40) Decimal Concepts and Rounding Off

Write in words: 1.005; round to tenths: 34.96

(41) Adding and Subtracting Decimals

$37 + 6.2 + 0.48$; $4.3 - 3.72$

(42) Multiplying Decimals and Using Powers of 10

1.84×0.3 ; 32.7×100 ; $32.7 \div 100$

(43) Dividing Decimals

$3.15 \div 3$; change $\frac{1}{8}$ to decimal; $1.837 \div 4$

(44) Ratio – Proportion

Write 300 mi on 15 gal. as ratio

Solve $\frac{x}{30} = \frac{5}{12}$; word problems

(45) Percent Concepts

40% = ? decimal = ? fraction ;

$\frac{3}{8}$ = ? % ; 2.4 = ? %

(46) Using Percents

54% of 25 = ? ; ? % of 20 = 5 ;

10% of ? = 3

(47) Percent Word Problems

discount , surveys , budgets , etc.

(48) Rectangular Coordinate System

plot $(-1,3)$, $(0,-5)$, $(4,0)$; read coordinates of graphed points

(49) Graphing a Linear Equation

$y = 3x - 2$; $3x - y = 7$; $x = 3$

(50) Solving Systems of Linear Equations: Graphing

$y = 2x - 4$
$y = 3x - 11$;
$y = x + 3$
$2y = 2x + 1$

Evaluation Checklist — Videotape

Student Name _____

Name of Tape _____

(1) Do you think this tape is too long? _____

(2) Do you think this tape is too short? _____

(3) Did the tape explain the ideas so that you understood them? If your answer is NO, which ideas needed more explanation?

_____

_____

_____

(4) Did the sample problems at the beginning help you understand the ideas?

_____

(5) Did the practice problems help you understand the ideas?

_____

(6) Did you do the practice problems? _____

If YES, did you get the answers correct? _____

How many did you get correct? _____

(7) Did the summary of rules and steps help you to understand the ideas? _____

(8) Was the writing on the board clear enough? _____

(9) Was the writing on the board large enough? _____

(10) Do you have any suggestions to improve the tape?

_____

_____

(11) Would you look at other tapes during the remainder of the course?

_____

_____

VIII
EVALUATIONS

Student Evaluation of Instructor

Please check the appropriate number after reading each statement *(4 is the most favorable, 1 is the least favorable).*

(1) The instructor was patient and understanding.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(2) The instructor presented lessons in a way that made math seem easier than before.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(3) The instructor made me feel comfortable about asking questions in class.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(4) If I needed extra help, I felt comfortable about seeing the instructor during office hours.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(5) Review sheets prepared by the instructor helped me to study for tests.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(6) The tests were fair and there was enough time to do them.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(7) I feel that the instructor treated students fairly.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(8) I would recommend this instructor to other students.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(9) I would take another course with this instructor.

If you have any other comments about your instructor, please write them here:

_____

_____

_____

Teacher Evaluation of Tutor

Indicate your opinion of the tutor by checking the appropriate space *(4 is most favorable, 1 is least favorable)*.

(1) The tutor is prompt and reliable.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(2) (2)The tutor works in a cooperative manner in the classroom.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(3) The tutor explains the concepts correctly.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(4) The tutor helps the student understand the assignments.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(5) The tutor is patient with the students.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(6) The tutor reinforces the teacher's presentation of material.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(7) The tutor follows the teacher's directions.

☐ 4 ☐ 3 ☐ 2 ☐ 1

(8) The tutor is liked and accepted by the students.

Any other comments:

_____

_____

_____

_____

_____

Student Satisfaction Questionnaire

Please check the appropriate number to indicate your satisfaction with each of the following *(4 is the most favorable response and 1 is the least favorable)*. Check "Don't know" for any service with which you are not familiar. Thank you for your cooperation.

(1) Textbooks used in the course:

☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ Don't know

(2) Method of instruction:

☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ Don't know

(3) Tutoring program:

☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ Don't know

(4) Student workshops:

☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ Don't know

(5) Computer software:

☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ Don't know

(6) Video tapes:

☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ Don't know

(7) Counseling:

☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ Don't know

(8) Services of the Office of Disabled Students:

☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ Don't know

(9) I feel satisfied with what I have learned in this course:

☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ Don't know

If you have any comments or suggestions, please write them here:

_____

_____

_____

_____

IX
APPENDIX

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Selected Resources

1. INFORMATION SOURCES

(A) COMPUTERS, SOFTWARE AND TECHNOLOGY

Apple Office of Special Education Programs
Apple Computer
20525 Mariana Ave. MS23D
Cupertino, CA 95014
408-973-6484

Center for Special Education Technology Information Exchange
1920 Association Drive
Reston, VA 22091
1-800-345-TECH

Closing the Gap
P.O. Box 68
Henderson, MN 56044
612-248-3294

IBM National Support Center for Persons with Disabilities
4111 Northside Parkway
Atlanta, GA 30327
404-238-3521
1-800-426-2133

Special Net
National Association of State Directors of Special Education
2021 K St. N.W. Suite 315
Washington, D.C. 20006
202-296-1800

(B) LEARNING DISABILITIES

Northeast Technical Assistance Center for Learning Disability College Programming (NETAC)
Dr. Loring C. Brinckerhoff, Project Coordinator
The University of Connecticut
School of Education
Special Education Center, U-64
249 Glenbrook Rd.
Storrs, CT 06269-2064
203-486-5035

(C) INFORMATION CLEARINGHOUSES

Educational Resources Information Center (ERIC)

ERIC Clearinghouse for Junior Colleges
8118 Math-Sciences Bldg.
University of California
Los Angeles, CA 90024

ERIC Clearinghouse on Handicapped & Gifted Children
1920 Association Drive
Reston, VA 22091
703-620-3660

ERIC Clearinghouse on Higher Education
George Washington University
One Dupont Circle NW Suite 630
Washington, DC 20036
202-296-2597

HEATH Resource Center, National Clearinghouse on Postsecondary Education for Handicapped Individuals
American Council on Education
One Dupont Circle NW
Suite 670
Washington, D.C. 20036-1193
800-54-HEATH

2. PROFESSIONAL ORGANIZATIONS

(A) LEARNING DISABILITIES

Association for Children and Adults with Learning Disabilities (ACLD)
4156 Library Rd.
Pittsburgh, PA 15234

Association on Handicapped Student Service Programs in Postsecondary Education (AHSSPPE)
P.O. Box 21192
Columbus, OH 43221
614-488-4972

Association of Learning Disabled Adults (ALDA)
P.O. Box 9722
Friendship Station
Washington, D.C. 20016

A Closer Look
Box 1492
Washington, D.C. 20013

Foundation for Children with Learning Disabilities (FCLD)
99 Park Ave.
New York, NY 10016
212-687-7211

National Network of Learning Disabled Adults (NNLDA)
800 N. 82nd Street Suite F2
Scottsdale, AZ 85257
602-941-5112

The Orton Dyslexia Society
724 York Rd.
Baltimore, MD 21204
301-296-0232
800-222-3123

Time Out to Enjoy
715 Lake Street Suite 100
Oak Park, IL 60301

(B) DEVELOPMENTAL EDUCATION

National Association for Developmental Education (NADE)
P.O. Box 60227
Chicago, ILL 60660
312-262-NADE

New York College Learning Skills Association (NYCLSA)
Susan Huard
Director, Developmental Studies
Community College of the Finger Lakes
Canandaegua, NY 14424

New York Metropolitan Association for Developmental Education (NYMADE)
℅ Hunter College SEEK-ARC Rm. 1013E
695 Park Ave.
New York, NY 10021

(C) **MATHEMATICS**

American Mathematics Association of Two-Year Colleges (AMATYC)
Amber Steinmetz, President
Santa Rosa Jr. College
Santa Rosa, CA 95401

National Council of Teachers of Mathematics (NCTM)
1906 Association Drive
Reston, VA 22091

New York State Mathematics Association of Two-Year Colleges (NYSMATYC)
Ernie Danforth, President
Corning Community College
Corning, NY 14830
607-962-9243

3. PROFESSIONAL JOURNALS

(A) **LEARNING DISABILITIES**

Academic Therapy
Academic Therapy Publications
20 Commercial Blvd.
Novato, CA

Journal of Learning Disabilities
PRO-ED Journals
5341 Industrial Oaks Blvd.
Austin, TX 78735

Journal of Reading, Writing and Learning Disabilities
Hemisphere Publishing Corp.
79 Madison Ave.
New York, NY 10016

Learning Disability
Council for Learning Disabilities
5341 Industrial Oaks Blvd.
Austin, TX 78735

(B) **MATHEMATICS**

AMATYC Review
Don Cohen, Editor
SUNY College of Agr. & Tech.
Cobbleskill, NY 12043

Arithmetic Teacher
National Council of Teachers of Mathematics
1906 Association Drive
Reston, VA 22091

Focus On Learning Problems in Mathematics
Center for Teaching/Learning Mathematics
P.O. Box 3149
Framingham, MA 01701

Mathematics Teacher
National Council of Teachers of Mathematics
1906 Association Drive
Reston, VA 22091

Project Materials

The following articles and materials are currently available from the project and may be ordered using the form on page 82.

1. ***A Guide for Teaching Remedial Mathematics to Students with Learning Disabilities*** (102 pages).

   This teaching guide has been developed for use by classroom teachers of remedial mathematics and by tutors who work with small groups or individual students. The materials are intended to focus attention on potential weaknesses of students with learning disabilities and to offer suggestions for presentation of topics in arithmetic and algebra as well as for remediation of specific difficulties.

   Each of the 370 problems listed in the guide represents a distinct skill or concept. The guide provides: a description of the sample problem, an understanding of the basic concepts embedded in the problem and underlying skills required to do the problem as well as remediation strategies. Sample problems may be found on pages 25-37.

2. **Videotapes**

   The project has developed fifty interactive videotapes (½-inch VHS format) designed to reinforce classroom instruction. The tapes provide fully worked-out examples for the student to model along with practice problems. The student is able to stop the tape, solve the problem, and then watch the teacher go through step-by-step explanation. They also feature discussion of concepts, rules, strategies, and commonly made errors. Rules are provided, first verbally and then in written form for the students to copy off the screen. The explanations of the practice problems include captions with key phrases from the rules and strategies. Students control the rate of learning by freeze-frame, fast-forward, and rewind.

   A list of the fifty tapes by topic may be found on pages 65-68.

3. ***A Review of Computer Software to Supplement the Teaching of Remedial Mathematics to Community College Students with Learning Disabilities*** (42 pages).

   This is a comprehensive review of more than 90 mathematics software packages including commercial software and software developed in-house by other educational institutions.

   A three-page checklist of desirable features was developed by experienced community college instructors and by the project's learning disabilities specialist for this review. Mathematical and educational factors as well as characteristics of learning disabled students were considered in the development of the evaluation criteria. For each packet we have listed purchasing information, including the publisher's name, address, telephone number, approximate cost, and critical comments.

4. ***Selected CAI Packages to Supplement the Teaching of Remedial Mathematics to Community College Students With Learning Disabilities*** (7 pages).

   The commercial software packages listed in this publication were selected from our "Review of Computer Software" for use in our Math project (see Item 3, page 79). The materials were chosen because of their presentation, the large number of practice problems, minimal reading requirements, immediate feedback, reinforcement, and remedial branching. For each package we have listed purchasing information as well as comments critical to our decision-making process. This document also includes new materials not previously listed including in-house software created by the project staff. This publication is included in the Handbook, Item 6, on pages 53-60.

5. **In-House Software Developed by the Project Staff**

   This software is user friendly and has a clear visual display. The user inputs the final answer after working out the problem on paper. A multiple-choice test format is utilized. The software provides immediate feedback and positive reinforcement. Remedial branching provides feedback to incorrect responses. The user may request hints.

   - ***Review of MOD II*** by Dr. Shailaja Nagarkatte.
     Includes: Algebraic Expressions, Integers and Signed Numbers, Introduction to Geometry.
   - ***Review of MOD III*** by Dr. Joseph Bertorelli.
     Includes: Solving Linear Equations, Word Problems, Graphing, Systems of Equations.
   - ***Review of MOD IV*** by Professor Reuvain Zahavy.
     Includes: Algebraic Products and Factoring, Algebraic Fractions and Fractional Equations, Quadratic Equations
   - ***Arithmetic Problem Generator for Whole Numbers, Decimals, and Fractions*** by Dr. Helga Schwartz

     This software provides a printout of randomly generated problems of a specific type selected from a menu of carefully graded examples. Answers, but not solutions, are provided in separate locations so that students may check their work. The program also provides a good tool for assigning extra practice in areas of difficulty, and a review of previously learned material.

6. ***Teaching Remedial Mathematics to Students with Learning Disabilities*** (80 pages)

This comprehensive handbook has been developed for use by classroom teachers, tutors who work with small groups or individual students, learning disabilities specialists, learning center personnel, and other service providers for this population.

The handbook contains information related to:

- Development of an appropriate curriculum;
- Characteristic difficulties of LD Math students;
- General classroom management techniques;
- Content specific teaching strategies;
- Principles and techniques for creating instructional videotapes;
- Teacher and tutor training materials;
- Selected student workshop agendas;
- Criteria for CAI selection;
- Testing in alternative modes and individualizing instruction.

A resource section includes suggested readings and organizations that provide assistance to the learning disabled.

The handbook is in a looseleaf format, enabling the user to duplicate the "how-to" lists, evaluation forms and sample materials easily.

Order Form

DEMONSTRATION PROJECT TO TEACH REMEDIAL MATHEMATICS
TO STUDENTS WITH LEARNING DISABILITIES
QUEENSBOROUGH COMMUNITY COLLEGE • BAYSIDE, NEW YORK 11364 • 718-631-6361

The following articles and materials are currently available from the Project. Please indicate your request by checking the appropriate box. If ordering videotapes, please specify the particular tape number. Costs cover production and mailing expenses only.

- ☐ 1. *A Guide for Teaching Remedial Mathematics to Community College Students with Learning Disabilities* (102 pages / $1.50, including mailing cost)
- ☐ 2. *Videotapes*. 50 tapes, ½-inch format (titles listed on pages 65-68 / $8.00 per tape, including mailing cost)
- ☐ 3. *A Review of Computer Software to Supplement the Teaching of Remedial Mathematics to Community College Students with Learning Disabilities.* (42 pages / $1.50, including mailing cost)
- ☐ 4. *Selected CAI Packages to Supplement the Teaching of Remedial Mathematics to Community College Students with Learning Disabilities.* (7 pages / $1.00, including mailing cost)
- ☐ 5. *Software*, developed by Queensborough Community College Faculty:
  - ☐ 5a. *Review of MOD II*, by Dr. Shailaja Nagarkatte ($5.00, including mailing cost)
  - ☐ 5b. *Review of MOD III*, by Dr. Joseph Bertorelli ($5.00, including mailing cost)
  - ☐ 5c. *Review of MOD IV*, by Professor Reuvain Zahavey ($5.00, including mailing cost)
  - ☐ 5d. *Arithmetic Problem Generator for Whole Numbers, Decimals, and Fractions*, by Dr. Helga Schwartz ($5.00, including mailing cost)
- ☐ 6. *Teaching Remedial Mathematics to Students with Learning Disabilities.* (80 pages / $10.00, including mailing cost)

Name _____

Title _____

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City, State, Zip Code _____

Telephone _____

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